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Comparison of 3 ankle braces in reducing ankle inversion in a basketball rebounding task

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Highlights

- All ankle braces reduced ankle and foot inversion when compared to the unbraced condition
- First study to examine dominant and non-dominant ankle inversion moments simultaneously in braced conditions

Abstract (Word count = 247 words)

Lateral ankle injury incidence rates are very high in the sport of basketball, with a significant proportion occurring during rebounding. Ankle braces are often used as preventative and rehabilitative techniques in hope of minimizing the likelihood of experiencing excessive ankle inversion. This study aims to evaluate the effect of different ankle braces in preventing ankle inversion during a basketball rebounding task.

Sixteen subjects participated in the study (11 males, 5 females; mean age = 26.94 years, SD=5.32; mean height 1.72 m, SD=0.08; mean weight 73.95 kg, SD=13.68).

Participants performed a simulated rebounding task in multiple braced conditions: unbraced (UB), Ossur Formfit (OF), Talarmade Ankleguard Air/Gel Stirrup (TAG) and Bauerfeind Malleoloc (BF). Ankle and foot inversion angles, ankle inversion moments and peroneus longus EMG activity were recorded and analysed to determine the effectiveness of each condition to resist inversion.

All braced conditions reduced ankle and foot inversion angles compared to UB. In the non-dominant limb, OF showed reduced maximum ankle inversion compared to BF (non-dominant mean difference = 0.630^{o}, $p<0.001$) and reduced foot inversion compared to TAG (non-dominant mean difference = 0.966^{o}, $p=0.035$). Compared to UB, OF and TAG increased ankle inversion moments in the dominant ankle and showed decreases in the non-dominant ankle. BF reduced mean peak peroneus longus EMG activity compared to all other trials.

Whilst statistically significant differences that were demonstrated between several braced conditions are relatively small, they are clinically significant knowing that the maximum barefoot inversion whilst standing is less than 17 degrees.

Key Words

Ankle Brace, Inversion, Basketball, Rebounding, Landing

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Introduction

Ankle injuries account for approximately 20% of all injuries suffered in sports [1]. The likelihood of suffering an ankle sprain is subject to a number of factors, but most notably the increased frequency for recurring ankle sprains following a primary injury [2-6]. Financial consequences can be significant when considering absence from work and other daily activities. Due to the frequent occurrence of ankle sprains and their resulting implications, several preventative and rehabilitative measures exist. Among these, the use of prophylactic ankle braces is often considered.

Several companies produce a variety of models of ankle braces. Models differ in terms of material and supportive features, but essentially serve the same purpose of stabilizing the ankle joint. The majority of ankle braces are designed to prevent excessive inversion motions, in order to protect the wearer from lateral ankle sprains. Such sprains are the most common ankle injury, involving damage to the lateral ankle complex due to excessive inversion [2]. Many designs involve a low-profile orthosis that can be used in everyday situations since the support fits inside most shoes.

The ability to provide mechanical support without compromising function is the most important factor when considering ankle braces in athletic situations. Several studies have been conducted concerning the effects of ankle braces on athletic performance, incidence rate of ankle injuries, and lower limb kinematics [7,8]. However, less is known about the effect of ankle braces on ankle joint kinematics while performing specific athletic movements.

This study aimed to collect kinetic and kinematic data of the ankle during a basketball rebounding task. The act of rebounding, or retrieving the ball after a missed shot attempt, is of particular interest since nearly half of all basketball-related foot and ankle injuries occur during this manoeuvre [3]. Ankle and foot inversion angles as well as electromyography (EMG) activity of the peroneus longus was measured to compare the effects of different ankle braces on their ability to stabilise the ankle joint complex. Additionally, ground reaction forces were measured to analyze the effects of the braces on the ankle inversion moments produced when landing.

Material and Methods

All data were collected at the XXX of the XXX Centre, XXX Hospital and Medical School XXX. Ethical permission was granted by the University's School of Medicine Research Ethics Committee prior to data collection.

Participants

Sixteen participants (eleven male, five female) agreed to take part in this study and were recruited by a number of means. Members of the University Women's Basketball Club and Mixed Lacrosse Club were invited to participate via email. Recreational basketball players at the Institute of Sport and Exercise were also invited to volunteer. In addition, a number of students who were completing research projects within the department were encouraged to participate if they had experience playing basketball.

Participants were required to be within the age range of 18-40 and be physically active. This was defined as participating in physical activity, either sport or exercise, at least twice a week. Due to the limited funds available to purchase ankle braces, participants were required to have a UK shoe size between six and eleven. This ensured that the range of braces acquired would properly fit each participant's foot and ankle according to manufacturer guidelines.

Experimental protocol

Participants attended the gait laboratory for a single testing session. Participants read a participant information sheet and completed a written consent form. They were also informed about the anonymous and confidential storage of the data collected over the course of the research project. Lower-limb dominance was determined by asking which foot participants would use to kick a ball. Anthropometric measurements of mass, height, leg length, inter-ASIS width, knee-width, and ankle-width were measured and recorded. Ankle circumference was measured to assign the appropriate size of ankle brace. A proper fitting VivoBarefoot Evo Pure shoe was worn by all participants due to its thin sole and short quarter piece. The same model of shoe was used to minimize inconsistencies in testing. Twenty-four retro-reflective markers were fixed to the participant, according to a 24-marker foot-inversion model, using double-sided adhesive tape. The peroneus longus muscle belly was identified and marked by asking the participant to plantarflex and evert their foot. The skin on the identified area was shaved and treated using NuPrep gel to improve electrical conduction. EMG sensors were fixed on each peroneus longus muscle belly using the Delsys Trigno™ Sensor Skin Interface (SC-F03) and further secured using adhesive medical tape.

3D motion analysis and ground reaction forces were captured using a fourteen-camera Vicon Nexus Motion Capture system (Vicon Motion Systems Ltd., Oxford, UK) operated at 200 Hz. EMG activity was captured through a Delsys Trigno™ Wireless System (Delsys Inc., Massachusetts, USA). Data were collected simultaneously through the Vicon software using a desktop computer.

Using a block-randomization process, participants were assigned the order in which they were to complete the four conditions: Talarmade Ankleguard Air/Gel Stirrup (TAG) (Figure 1), Ossur Formfit (OF) (Figure 2), Bauerfeind Malleoloc (BF) (Figure 3), and unbraced (UB). Ankle width was measured prior to the beginning of testing each condition to accompany the changes in width of the different braces.

<u>Rebounding apparatus</u>

The apparatus was designed and built within the department. The basketball was suspended from the device's lowest point using Velcro. The height at which the ball rested was adjustable to accommodate participants of different heights and jumping capabilities (Figure 4).

<u>Rebounding task</u>

Participants performed their regular exercise or sporting warm-up routine and were familiarized with the rebounding task prior to data collection. The ball was set to a height that required the participant to jump in order to retrieve it, but remained attainable over a minimum of 20 trials. During the rebounding task, participants began with each of their feet on its respective plate, at a width they would use naturally to jump. When signalled, participants would jump vertically, securing the basketball, and land back down on the force plates (Figure 4). Both feet were required to land completely on their respective force plates in order for the trial to be deemed successful. The rebounding task was performed under the four conditions and was repeated until five successful trials were obtained for each condition.

Data analysis

Using Vicon Nexus software, a 3D representation of each trial was formulated by manually marking all the reflective markers and running a custom foot inversion Pipeline. Gaps in the data were filled using the appropriate gap filling techniques.

Data from the whole trial were used when considering the maximum ankle and foot inversion angles. However, when observing maximum ankle inversion moments and EMG activity of the peroneus longus, only data from the landing portion of the trial were considered. There were two reasons for this. The first reason was that there were no ground reaction forces present while the participant was in the air, therefore joint moments could not be calculated. Secondly, in each trial the peroneus longus had two spikes in EMG activity: while jumping, and while landing. The spike in activity due to the jump, if included in analysis, could alter the interpretation of how the braces affected peroneus longus activity, and thus how the ankle and foot are stabilized during the landing portion.

Statistical Analysis

Data were analysed using IBM SPSS Version 22. The General Linear Model was used to calculate mean estimates of the four conditions, followed by pairwise comparisons to define any significant differences between these conditions. A p-value of 0.05 was used to establish statistical significance.

Results

A total of 16 participants completed the study. For quality purposes, data from 15 participants was included for calculations involving maximum ankle and foot inversion angles as well as ankle inversion moments, whilst data from 14 participants was used for analysis of EMG activity of the peroneus longus. Regarding ankle and foot inversion angles as well as ankle inversion moments, data from one participant was excluded due to excessive gaps in Vicon data. Regarding EMG, data was excluded from two participants due to technical difficulties with the electrodes.

Table 1: Sample means for maximum ankle and foot inversion angles, maximum ankle inversion moments, mean peak EMG activity of peroneus longus and peak value EMG activity of peroneus longus for unbraced (UB), Ossur Formfit (OF), Talarmade Ankleguard (TAG) and Bauerfeind Malleoloc (BM) trials. Values are presented as sample mean ± standard deviation for the dominant (D) and non-dominant (ND) limbs

	Maximum ankle inversion (degrees)		**Maximum foot inversion (degrees)**		**Maximum ankle inversion moments (Nm/kg)**		**Mean peak EMG activity of peroneus longus (mV)**		**Peak EMG activity of peroneus longus (mV)**	
	D	ND	D	ND	D	ND	D	ND	D	ND
UB	5.719 ± 3.984	6.568 ± 5.131	7.422 ± 3.229	7.048 ± 3.237	0.283 ± 0.200	0.359 ± 0.259	0.0354 ± 0.0192	0.0555 ± 0.0285	0.0982 ± 0.0394	0.0795 ± 0.0270
OF	4.012 ± 2.865	4.315 ± 3.929	5.669 ± 2.885	4.086 ± 2.733	0.331 ± 0.317	0.303 ± 0.195	0.0320 ± 0.0171	0.0554 ± 0.0344	0.0931 ± 0.0352	0.0874 ± 0.0504
TAG	4.147 ± 3.195	4.501 ± 4.489	6.558 ± 2.898	5.052 ± 2.859	0.322 ± 0.278	0.322 ± 0.204	0.0366 ± 0.0333	0.0558 ± 0.0286	0.1046 ± 0.0914	0.0790 ± 0.0241
BF	4.198 ± 2.970	4.945 ± 4.621	5.675 ± 1.811	4.428 ± 2.480	0.291 ± 0.237	0.310 ± 0.213	0.0275 ± 0.0142	0.0463 ± 0.0260	0.0929 ± 0.0380	0.0846 ± 0.0604

Table 2: Pairwise comparisons between unbraced (UB), Ossur Formfit (OF), Talarmade Ankleguard (TAG) and Bauerfeind Malleoloc (BM) in the dominant limb

PARAMETER	I	J	MEAN DIFFERENCE (I-J)	STD. ERROR	P-VALUE
MAXIMUM ANKLE INVERSION (^{O})	UB	OF	1.715*	.173	.000
		TAG	1.627*	.590	.007
		BF	1.509*	.155	.000
	OF	UB	-1.715*	.173	.000
		TAG	-0.088	.478	.855
		BF	-0.206*	.100	.043
	TAG	UB	-1.627*	.590	.007
		OF	0.088	.478	.855
		BF	-0.118	.504	.816
	BF	UB	-1.509*	.155	.000
		OF	0.206*	.100	.043
		TAG	0.118	.504	.816
MAXIMUM ANKLE INVERSION MOMENT (NM/KG)	UB	OF	-0.048*	0.018	.011
		TAG	-0.039*	0.015	.011
		BF	-0.008	0.040	.839
	OF	UB	0.048*	0.018	.011
		TAG	0.009	0.014	.511
		BF	0.040	0.049	.419
	TAG	UB	0.039*	0.015	.011
		OF	-0.009	0.014	.511
		BF	0.031	0.047	.509
	BF	UB	0.008	0.040	.839
		OF	-0.040	0.049	.419
		TAG	-0.031	0.047	.509
MAXIMUM FOOT INVERSION (^{O})	UB	OF	1.732*	.416	.000
		TAG	0.894	.523	.093
		BF	1.738*	.438	.000
	OF	UB	-1.732*	.416	.000
		TAG	-0.838	.489	.093
		BF	0.006	.327	.985
	TAG	UB	-0.894	.523	.093
		OF	0.838	.489	.093
		BF	0.844*	.381	.031
	BF	UB	-1.738*	.438	.000
		OF	-0.006	.327	.985
		TAG	-0.844*	.381	.031
MEAN PEAK PERONEUS LONGUS EMG ACTIVITY (MV)	UB	OF	0.003	.002	.131
		TAG	-0.001	.004	.791
		BF	0.008*	.002	.002
	OF	UB	-0.003	.002	.131
		TAG	-0.005	.005	.317
		BF	0.004	.002	.074
	TAG	UB	0.001	.004	.791
		OF	0.005	.005	.317
		BF	0.009*	.004	.033
	BF	UB	-0.008*	.002	.002
		OF	-0.004	.002	.074
		TAG	-0.009*	.004	.033
PEAK VALUE PERONEUS LONGUS ACTIVITY (MV)	UB	OF	0.005	.006	.395
		TAG	-0.007	.011	.569
		BF	0.005	.006	.362
	OF	UB	-0.005	.006	.395
		TAG	-0.012	.012	.327
		BF	0.000	.005	.970
	TAG	UB	0.007	.011	.569
		OF	0.012	.012	.327
		BF	0.012	.010	.245
	BF	UB	-0.005	.006	.362
		OF	0.000	.005	.970
		TAG	-0.012	.010	.245

Table 3: Pairwise comparisons between unbraced (UB), Ossur Formfit (OF), Talarmade Ankleguard (TAG) and Bauerfeind Malleoloc (BM) the non-dominant limb

PARAMETER	I	J	MEAN DIFFERENCE (I-J)	STD. ERROR	P-VALUE
MAXIMUM ANKLE INVERSION (^{O})	UB	OF	2.275*	.187	.000
		TAG	2.317*	.944	.017
		BF	1.636*	.140	.000
	OF	UB	-2.275*	.187	.000
		TAG	0.041	.810	.959
		BF	-0.640*	.141	.000
	TAG	UB	-2.317*	.944	.017
		OF	-0.041	.810	.959
		BF	-0.681	.862	.432
	BF	UB	-1.636*	.140	.000
		OF	0.640*	.141	.000
		TAG	0.681	.862	.432
MAXIMUM ANKLE INVERSION MOMENT (NM/KG)	UB	OF	0.056*	.018	.003
		TAG	0.037	.020	.066
		BF	0.049	.046	.294
	OF	UB	-0.056*	.018	.003
		TAG	-0.019	.013	.151
		BF	-0.007	.038	.853
	TAG	UB	-0.037	.020	.066
		OF	0.019	.013	.151
		BF	0.012	.039	.764
	BF	UB	-0.049	.046	.294
		OF	0.007	.038	.853
		TAG	-0.012	.039	.764
MAXIMUM FOOT INVERSION (^{O})	UB	OF	3.031*	.516	.000
		TAG	1.996*	.552	.001
		BF	2.599*	.554	.000
	OF	UB	-3.031*	.516	.000
		TAG	-1.034*	.387	.010
		BF	-0.432	.335	.203
	TAG	UB	-1.996*	.552	.001
		OF	1.034*	.387	.010
		BF	0.602	.367	.107
	BF	UB	-2.599*	.554	.000
		OF	0.432	.335	.203
		TAG	-0.602	.367	.107
MEAN PEAK PERONEUS LONGUS EMG ACTIVITY (MV)	UB	OF	5.848E-5	.005	.990
		TAG	0.000	.004	.927
		BF	0.009*	.004	.032
	OF	UB	-5.848E-5	.005	.990
		TAG	0.000	.005	.930
		BF	0.009	.005	.075
	TAG	UB	0.000	.004	.927
		OF	0.000	.005	.930
		BF	0.010*	.004	.023
	BF	UB	-0.009*	.004	.032
		OF	-0.009	.005	.075
		TAG	-0.010*	.004	.023
PEAK VALUE PERONEUS LONGUS ACTIVITY (MV)	UB	OF	-0.008	.007	.268
		TAG	0.000	.004	.912
		BF	-0.005	.008	.547
	OF	UB	0.008	.007	.268
		TAG	0.008	.006	.191
		BF	0.003	.009	.752
	TAG	UB	0.000	.004	.912
		OF	-0.008	.006	.191
		BF	-0.006	.007	.426
	BF	UB	0.005	.008	.547
		OF	-0.003	.009	.752
		TAG	0.006	.007	.426

Discussion

Maximum ankle inversion angles

When compared to UB in the dominant side, OF, TAG and BF reduced ankle inversion by 1.707^{o} ($p < 0.001$), 1.572^{o} ($p = 0.009$) and 1.521^{o} ($p < 0.001$), respectively. Although there were no significant differences between braces conditions, OF showed a reduction of 0.186^{o} ($p = 0.067$) when compared to BF.

Similarly to the dominant leg, all braced conditions reduced ankle inversion when compared to UB. OF, TAG, and BF significantly reduced ankle inversion by 2.252^{o} ($p < 0.001$), 2.067^{o} ($p = 0.035$) and 1.623^{o} ($p < 0.001$) respectively. Additionally, OF reduced ankle inversion by 0.630^{o} ($p < 0.001$) when compared to BF.

Whilst the present study suggests all braced conditions reduced ankle inversion when compared to the control group, only semi-rigid braces reduced ankle inversion during forced inversion trials, whilst lace-up braces showed no significant differences from the control group [7]. Similarly, less ankle inversion has been observed in semi-rigid ankle braces than in lace-up ankle braces while performing a change-of-direction manoeuvre [8]. Considering these two studies and the present results, it may be suggested that differences arise due to the nature of the task, thus the degree of protection provided by specific braces against ankle inversion may be dependent on the activities being performed.

Maximum foot inversion angles

When compared to UB, OF and BF significantly reduced the maximum foot inversion angle in the dominant foot by 1.753^{o} ($p < 0.001$) and 1.747^{o} ($p < 0.001$). TAG also appeared to reduce foot inversion by 0.864^{o} ($p = 0.093$) when compared to UB but did not reach statistical significance. When compared to TAG, BF significantly reduced the foot inversion angle by 0.0884^{o} ($p = 0.020$), while OF showed a reduction of 0.889^{o} ($p = 0.066$) nearly reaching statistical significance.

All braced conditions reduced maximum foot inversion in the non-dominant leg when compared to UB. OF, TAG, and BF decreased the maximum foot inversion angle by 2.962^{o} ($p < 0.001$), 1.996^{o} ($p < 0.001$) and 2.620^{o} ($p < 0.001$), respectively. When considering TAG, OF significantly reduced the maximum foot inversion by 0.966° ($p = 0.012$) while the reduction seen by BF is on the cusp of statistical significance (0.624°, $p = 0.079$). Despite attaining statistically significant differences in ankle and foot inversion angles between trials, the clinical significance of these findings may be disputed. However, as maximum standing foot inversion angle is less than 17°, a reduction of 1° would yield a relative decrease of nearly 6% and therefore must be considered clinically significant [9, 10].

The loading required to cause an injury changes with different positions of the foot [11]. Being able to control, or maintain awareness of, the position of the foot whilst in the air may play a role in preventing foot and ankle injuries.

The reduction in foot inversion seen in the present study may be influenced by the design of the ankle braces. TAG possesses only two straps to secure the medial and lateral stirrups to each other. The straps wrap around the leg, perpendicularly to the long axis of the brace, and are fastened using Velcro. They do not at any point cross over each other. OF and BF use straps that cross each other on the anterior portion of the shank. Furthermore, the OF and BF are more securely positioned under the heel. This, in combination with the crossing of straps may provide additional support, and/or keep the stirrups of the braces in better positions to resist inversion motions.

Maximum ankle inversion moments

When compared to UB, OF and TAG showed a significant increase in the maximum ankle inversion moment in the dominant ankle by 0.048 Nm/kg ($p = 0.011$) and 0.039 Nm/kg ($p = 0.011$), respectively. No significant differences existed between the braces.

In the non-dominant ankle, when compared to UB only OF showed a significant difference in reducing the maximum ankle inversion moment by 0.056 Nm/kg ($p = 0.003$). TAG also showed evidence of decreasing the maximum ankle moment by 0.037 Nm/kg ($p = 0.066$), but does not quite reach statistical significance. No significant differences existed between braced conditions.

When compared to UB, the increases on the dominant side and decreases on the non-dominant side suggest that participants relied more heavily on their dominant limb to perform the task in braced conditions. Some studies have shown that athletes tend to favour their dominant side for jumping, kicking and landing [12,13]. However, these studies did not observe the effects of braces on lower limb kinetics.

Mean peak EMG value of peroneus longus during landing

When compared to BF, both UB and TAG demonstrated significant increases in mean peak EMG value in the dominant leg, with increases of 0.0079 mV ($p = 0.002$) and 0.0091 ($p = 0.033$), respectively. OF reports a slight increase of 0.0045 mV ($p = 0.074$), narrowly missing statistical significance.

Similar results were seen in the non-dominant leg. When compared to BF, both UB and TAG demonstrated significant increases in mean peak EMG value, with increases of 0.0092 mV ($p = 0.032$) and 0.0095 ($p = 0.023$), respectively. OF displayed an increase of 0.0091 mV ($p = 0.075$) and nearly reached statistical significance.

The reduction in peroneus longus activity displayed by BF can be interpreted in two ways. The first interpretation suggests that the brace is providing mechanical support, and resisting inversion, therefore the peroneus longus, being the primary evertor of the foot, does not have to activate so intensely. The second idea proposes that the external support actually inhibits the muscle, and may in fact pose an increased risk of ankle inversion injury to the wearer [14]. It is unclear as to whether this phenomenon holds, since both OF and TAG decrease inversion of the foot and ankle compared to UB. Therefore, a reduction in inversion is not necessarily associated with decreases in peroneus longus muscle activity.

In a study examining change of direction manoeuvres, no significant differences in mean peroneus longus activity were noted between braced and unbraced trials [15]. This inconsistency in results may be explained by the different tasks performed or the types of braces worn.

Peak EMG value of peroneus longus during landing

No significant differences were found concerning peak EMG activity between any of the conditions. The similar peak EMG readings between conditions may be explained by the repetitive motion of retrieving the ball from a consistent height. Similar consistencies have been found in other studies which involve performing an athletic task repeatedly. No significant differences in peak peroneus longus activity were observed while performing change of direction manoeuvres in braced and unbraced conditions [15], nor between semi-rigid and lace-up braces [14].

However, the latter study did report a decrease in EMG activity in the braced conditions when compared to the unbraced trials [14]. This raises concerns as to how differences in experimental procedures and protocols may yield different results, despite relative similarities. Therefore, further studies should be conducted in an attempt to more accurately describe the effects of ankle bracing on peak EMG activity of the peroneus longus during athletic trials.

Limitations

Due to the relatively small sample size, nearly statistically significant values were mentioned several times in the discussion section. These were mentioned when statistically significant differences were noted in the opposing limb in the conditions being considered. Further studies should include larger sample sizes to observe whether these differences would reach statistical significance with more participants.

It is important to consider that data were not collected during an actual basketball game. The task that was performed allowed for safe and successful completion. Therefore, the simulated rebounding task did not include many of the factors that may contribute to lateral ankle injuries sustained during a match.

Consistencies in peroneus longus activity may be explained by the lack of horizontal movement and the consistent height of the basketball during trials. Adding lateral movement to a similar study, as well as varying the height of the suspended basketball, may provide more realistic interpretations as to how ankle braces affect peroneus longus activity during game situations.

Variability within the data may be due to the array of athletic profiles possessed by participants. Both the type of sport, as well as the level of competition, could influence the results. In order to improve this, recruitment could involve a specific core of athletes who compete at the same level. However, the range of athletic profiles allowed for more general consensuses concerning the effectiveness of the braces in reducing ankle inversion.

Future considerations

The aim of this study was to evaluate the effects of different ankle braces on resisting ankle inversion in a basketball rebounding task. However, no inter-limb differences were analyzed within each condition. In braced conditions, the increased ankle inversion moments on the dominant side and decreases on the non-dominant side suggest that there are some changes in landing kinematics versus those observed in the unbraced condition. Future studies should consider investigating EMG activity of other lower limb muscles involved in jumping and landing in order to understand better how forces are distributed while wearing braces bilaterally.

Pressure platforms or insoles could be used while performing a rebounding task to further understanding of how weight distribution is affected while wearing ankle braces. Pressure distribution in combination with other kinetic and kinematic data would provide valuable information regarding how the ankle and foot behave during jumping and landing. Additionally, pressure sensors within the shoe/ankle braces would provide information concerning the proper fitting of braces.

In addition to peak EMG values, the time required to reach this maximum should be considered. People suffering from chronic ankle instability demonstrate slower eversion reaction times [16]. Perhaps more can be learned from the time required to reach peak peroneus longus activity, rather than the magnitude of the peak itself.

Furthermore, to better understand how the braces affect ankle and foot inversion throughout the course of the trial, future studies should investigate these values at specific points in the rebounding task. These could include, for example, inversion angles at maximum loading, the instant prior to landing and on landing as these may be when ankle sprains occur with varying footwear configurations [17].

Conclusion

There is an overall agreement throughout the literature that wearing ankle braces provides protection against ankle inversion injuries, likely through the increased mechanical support they provide. However, the effect of ankle braces on peroneus longus activity is not consistent throughout the literature and needs to be further explored.

This research study aimed to investigate the effect of wearing different ankle braces in reducing ankle inversion, specifically in a basketball rebounding task. By examining the inversion angles of the foot and ankle, the inversion moments of the ankle joint, and the muscle activity of the primary evertor of the foot, a general idea can be conceived regarding how ankle braces protect the foot during this precise task.

All braces reduced ankle and foot inversion when compared to the unbraced condition. The lace-up brace (Ossur Formfit) reduced ankle inversion compared to one semi-rigid brace (Bauerfeind Malleoloc), and also reduced foot inversion when compared to the second semi-rigid brace (Talarmade Airguard Air/Gel Stirrup). Bauerfeind Malleoloc reported lower mean peak EMG in the peroneus longus compared to all other conditions. However, no peak value EMG differences were noted between any of the conditions.

Of the ankle braces examined, the Ossur Formfit seems to be the most efficient ankle brace overall in preventing ankle inversion during the rebounding task. This was demonstrated by its ability to restrict ankle and foot inversion better than the Bauerfeind Malleoloc and Talarmade Ankleguard Air/Gel Stirrup, respectively. Since rebounding is one of many actions performed during basketball, research using these same braces in different basketball manoeuvres should be conducted to deduce which brace offers the best overall protection. This would in turn would help clinicians and athletic coaches provide reliable recommendations thus reducing the risk of ankle injury.

Brief Summary

What is known

- There is a general consensus in the literature that semi-rigid and lace-up ankle braces are effective in preventing ankle inversion.
- Semi-rigid braces are more efficient in reducing ankle inversion in change of direction manoeuvres, however less is known about how the braces perform in the array of tasks performed during an actual basketball game.

What this study adds

- The results suggest that lace-up ankle braces are the most effective design of brace in resisting ankle inversion in a basketball rebounding task, as seen in the reduction of ankle and foot inversion when compared to the semi-rigid braces.
- Peak peroneus longus activity is not affected by wearing ankle braces during the landing portion of the trial.
- There is some evidence that semi-rigid ankle braces reduce mean peak peroneus longus activity during the landing portion of the trial.

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Figure captions

Figure 1 Talarmade Ankleguard Air/Gel Stirrup

Figure 2 Ossur Formfit

Figure 3 Bauerfeind Malleoloc

Figure 4 Rebounding task